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## Tire Pressure Monitoring Systems

Subject Page

# Tire Pressure Monitoring Systems

Model: All with TPMS

Production: All

## OBJECTIVES

After completion of this module you will be able to:

- Identify BMW Tire Pressure Monitoring Systems
- Locate and Identify Components of TPM Systems
- Diagnose and Repair TPM Systems

# Introduction

According to numerous studies and statistical analysis, many vehicles on the roads today are driving with under-inflated tires. First and foremost, this a safety issue which could ultimately result in catastrophic tire failure (a.k.a. “blowout”). Many "blow-outs" can be traced back to preliminary damage from puncture or a slow loss in tire pressure.

In addition to safety issues, under-inflated tires can cause a reduction in fuel economy and overall tire life. Studies by tire manufacturers have shown that tire life can be reduced by 50% when the tires are under-inflated by as little as 20%.

Therefore the overall consequences of improperly inflated tires include:

- Increased tire wear resulting in decreased tire service life
- Impaired vehicle handling
- Reduction in safety for the vehicle occupants
- Reduced fuel economy

Since most tire pressure loss occurs gradually, the driver does not usually perceive the reduced tire pressure. Therefore various systems have been developed to aid the driver by monitoring tire pressure loss and report this information to the driver.

The intent of this training module is to include all systems which monitor tire pressure loss. The first U.S. model BMW to utilize this technology was the E39 M5. Various systems have been in use since that time on some models.

Recent government legislation now mandates that all light vehicles sold in the U.S. must have a “Tire Pressure Monitoring System” or TPMS.

## TREAD Act

In 2000, there was much media attention surrounding tire safety issues. The leading tire manufacturers were involved with many law suits regarding catastrophic tire failures. These well publicized incidents involved injury and fatalities.

In response to these issues, the U.S. Congress enacted legislation entitled the "Transportation Recall Enhancement, Accountability and Documentation (TREAD) Act in November of 2000.

The TREAD Act encompasses many aspects of tire industry issues. The act includes items such as tire labeling requirements, tire testing standards, information on tire safety related recalls etc. There are also provisions for issues on child safety restraints.

However, the focus of this training module is to train technicians about Tire Pressure Monitoring Systems (TPMS). TPM systems are also one of the primary components of the TREAD Act. TPM systems allow early detection of tire pressure loss which is not usually detected by the driver until vehicle handling and safety is affected.

The National Highway Traffic Safety Administration (NHTSA) is the government agency responsible for the creation and enforcement of the mandates of the TREAD Act. Initially, NHTSA approved the installation of "Indirect" TPM systems.

Indirect TPM systems monitor tire pressure "indirectly" by monitoring the rotational speed of the tire via the wheel speed sensors. The ABS/DSC system can then detect pressure loss by comparing wheel speed information between all 4 tires. Any loss in tire pressure would result in a change in tire diameter and therefore a change in rotational speed.

The guidelines of the TREAD Act found that "Indirect" TPM systems are ineffective in detecting tire pressure loss until the tire was under-inflated to an unsafe level. Therefore, NHTSA mandated that auto manufacturers install "Direct" TPM systems on all vehicles.

Direct TPM systems monitor tire pressure directly by using pressure sensors at each wheel which report tire pressure and temperature information to relevant vehicle systems. Tire pressure loss is then reported to the driver via an illuminated warning symbol. Direct TPM systems also offer the capability of monitoring tire pressure when the vehicle is at a standstill. Indirect systems must be driven in order to collect sufficient data to detect tire pressure loss.

As per NHTSA guidelines, passenger cars and light trucks must have the "Direct" TPM systems installed via a specific timeline from 2005. By 2007, all auto manufacturers must be in 100% compliance.

Aside from the obvious safety benefits, Direct TPM systems will also assist the driver by maintaining fuel economy and extending tire life.

This training module will help the technician to diagnose and repair both "Indirect" and "Direct" TPM systems. The first step in the diagnosis the these systems is identification. The following text shows some tips on identifying these systems.

## System Identification and Terminology

In order to accurately diagnose TPM systems, the system must be properly identified. These systems have had numerous acronyms which are used to describe the various systems. For the purposes of this training module, the systems will be broken down into two basic configurations. These are as follows:

- Systems which monitor wheel speed - These "Indirect" systems will be referred to as Flat Tire Monitoring systems or FTM. FTM systems take advantage of components already installed in the vehicle. The wheel speed sensors, which are already an input to the DSC control unit, are used to monitor wheel speed. When a tire starts to deflate, the overall diameter changes. This affects the rotational speed, which is picked up by the DSC module. The DSC module contains software for the purpose of calculating the speed changes and reporting the pressure loss to the driver via an illuminated indicator or symbol. The only additional components which are installed is the switch for system initialization. Early generation systems used a module which received wheel speed input from the DSC module.
- Systems which monitor actual tire pressure - These "Direct" systems will be referred to as Tire Pressure Monitoring Systems or TPM systems. TPM systems use wireless sensors which are part of the tire valve stem. These sensors monitor actual tire pressure and send this information to a module via multiple antennae. These systems are preferred due to the fact that the actual tire pressure is monitored rather than by variations in tire rotational speeds.

There is a simple way to identify the difference between the two systems. On systems which monitor actual tire pressure, the tire valve stem is threaded and has a "hex head" on the valve stem. The systems which monitor wheel speed have conventional rubber valve stems.

TPM System

"Threaded" Valve stem on vehicles which monitor actual tire pressure.

FTM System

"Rubber" Valve stem on vehicles which monitor wheel speed.

# Flat Tire Monitoring Systems

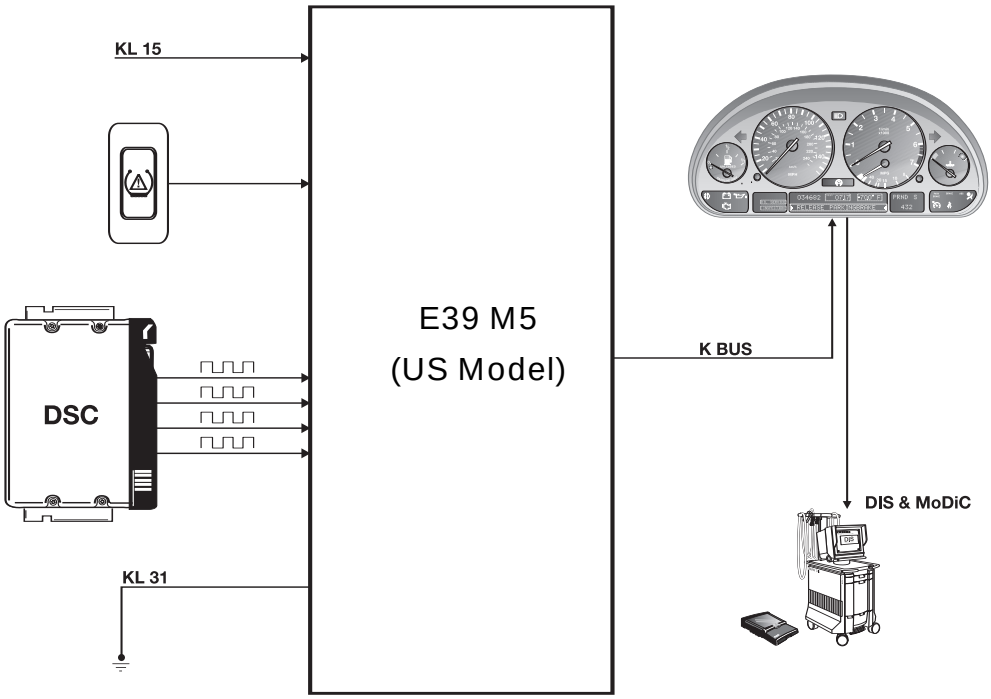
FTM systems are “indirect” systems which were first used on U.S. models with the introduction of the E39 M5 in 2000. Since that time, FTM systems have been included on most other models including the 7 Series.

There have been numerous abbreviations and terminology used to describe FTM systems in the past. However, FTM will be used from this point forward to describe those systems which “indirectly” monitor tire pressure loss through wheel speed detection.

Some of the past abbreviations include:

- RDW - is derived from the German term “Reifen Druck Warnung” which means Tire Pressure Warning. This term was used to describe some of the early systems used on the E39 M5 and E46 M3.
- RPA - comes from the German words “Reifen Pannen Anzeige” which translates to Tire Failure (Puncture) Indicator. This abbreviation is most closely associated with the E85, E60 and E46 (from 2001).
- DDS - This an english based abbreviation for Deflation Detection System. This term is occasionally found when using the diagnostic equipment such as the DISplus/GT-1.
- DWS - This is also an english abbreviation for the system used on the Z8 (E52) and it stands for Dunlop Warning System.

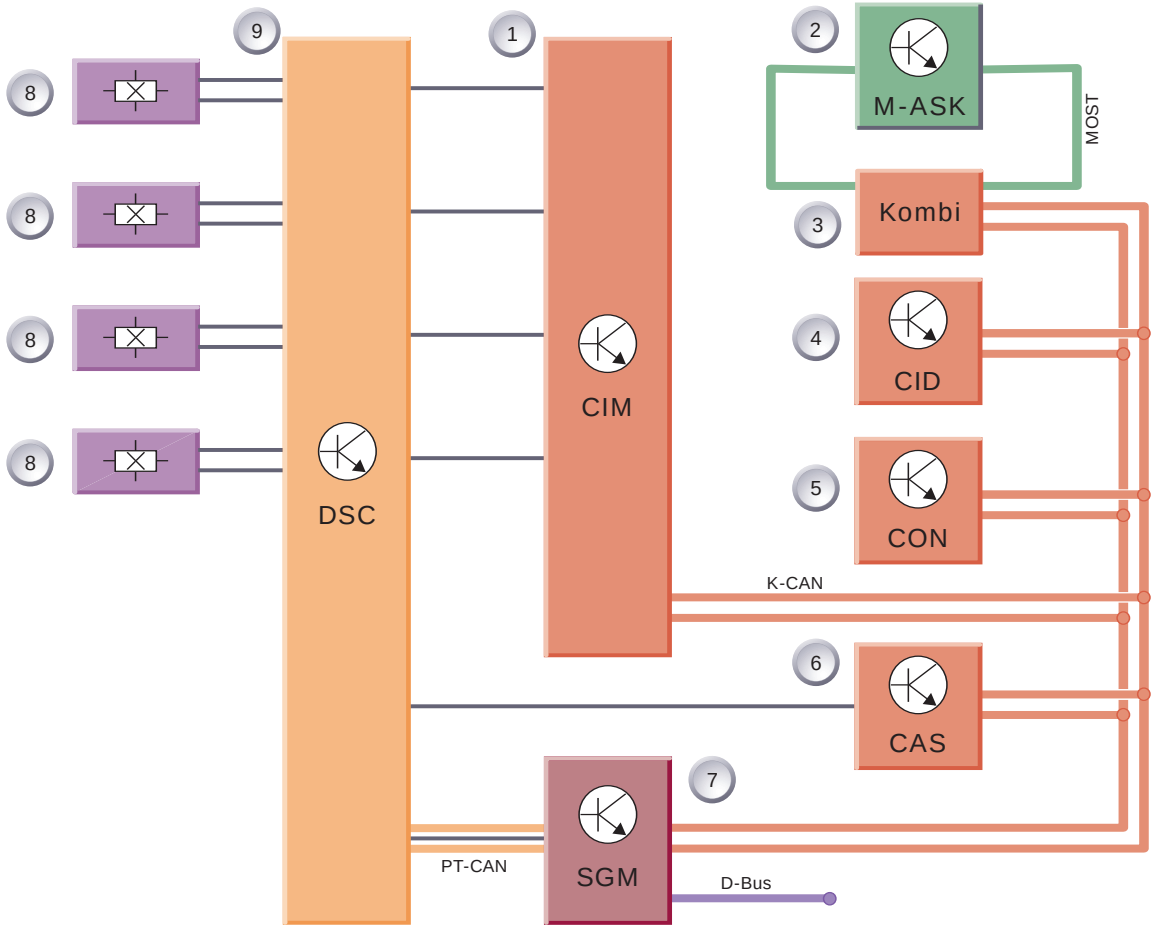
Regardless of the terminology used, the most important concept to understand is the difference between the Direct and Indirect systems.



## FTM System Overview

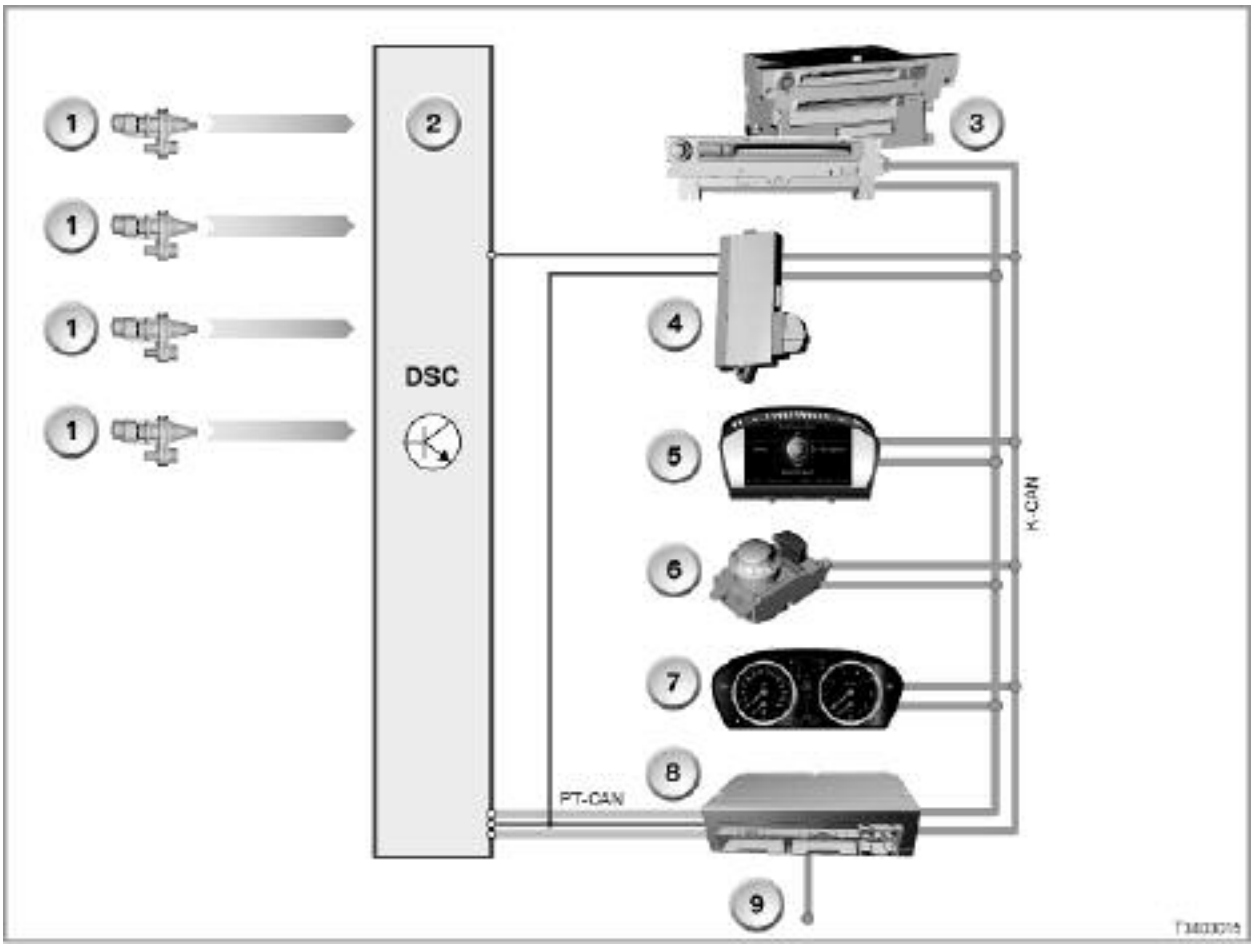
| FTM Systems (Indirect monitoring systems) | | | | | |
|---|---|---|---|---|---|
| Series | Chassis | Option/Date | System Design | Deflation Warning | System Reset (initialization) |
| 3 Series | E46 | Option from 9/03 | System integrated into DSC | Yellow telltale + gong | RPA Reset Button |
| 3 Series | E46 M3 | Standard from SOP | System integrated into DSC | Yellow telltale + gong | RPA Reset Button |
| 3 Series | E46 (ix) | Option from 9/01 | System uses separate control unit. | Yellow telltale + gong | RPA Reset Button |
| 3 Series | E90/E91 | Standard from SOP | System integrated into DSC | Yellow telltale + gong | RPA Reset via Stalk Switch or Controller |
| 5 Series | E39 (M5) | Standard | System uses separate control unit. | Yellow telltale + gong | RPA Reset Button |
| 5 Series | E60/E61 | Standard | System integrated into DSC | Yellow telltale + gong and CC Message | Soft Key Reset via CID Menu and Controller |
| 6 Series | E63/E64 | Standard | System integrated into DSC | Yellow telltale + gong and CC Message | Soft Key Reset via CID Menu and Controller |
| 7 Series | E65/E66 | Optional from 9/02 Standard from 12/03 | System integrated into CIM | Yellow telltale + gong and CC Message | Soft Key Reset via CID Menu and Controller |
| Z4 | E85 | Standard | System integrated into DSC | Yellow telltale + gong | RPA Reset Button |
| SAV | E53 | Standard from 4/04 | System integrated into DSC | Yellow telltale + gong | RPA Reset Button |
| SAV | E83 | Standard | System integrated into DSC | Yellow telltale + gong | RPA Reset Button |

# FTM System Overview (E65/E66)



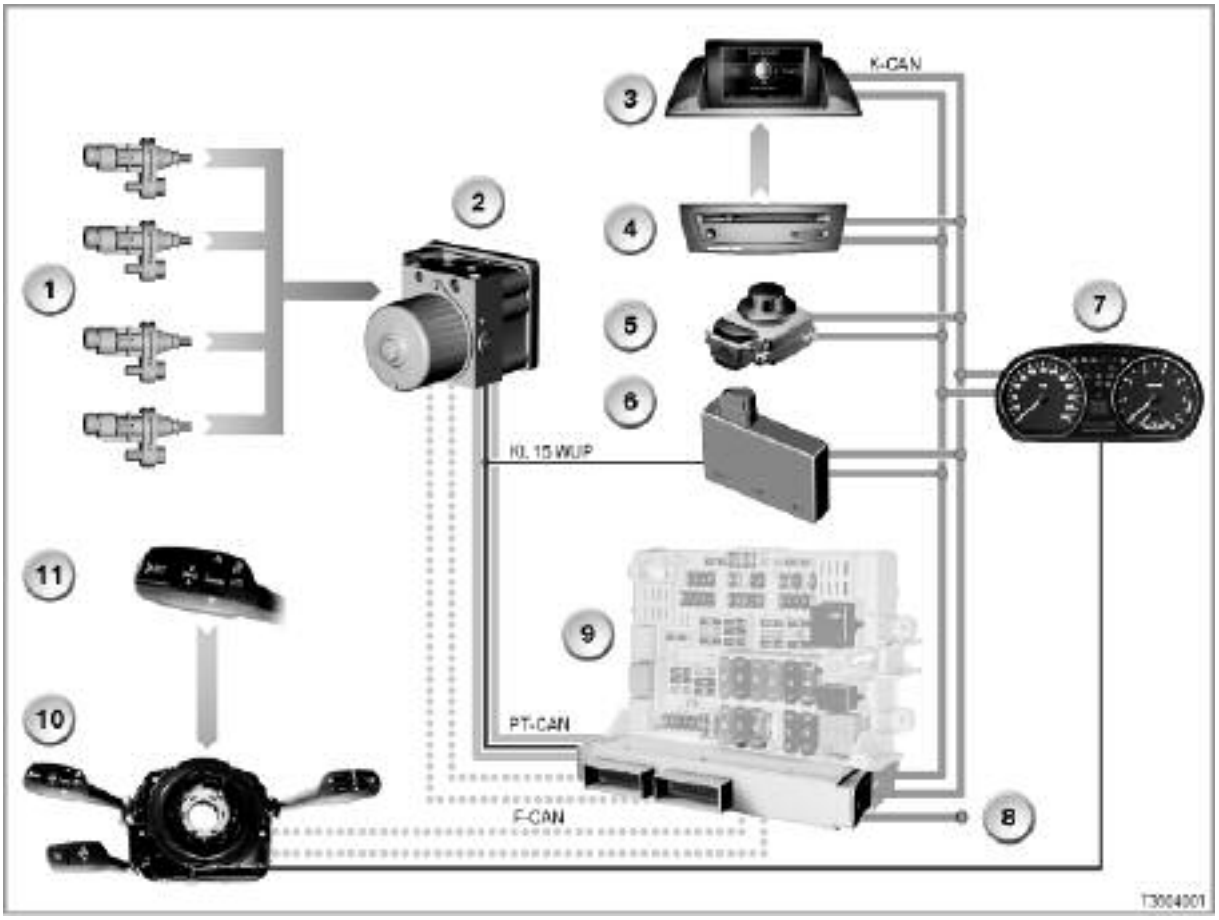

| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | Chassis Integration Module | 6 | Car Access System |
| 2 | Multi-Audio System Controller | 7 | Safety and Gateway Module |
| 3 | Kombi | 8 | Wheel Speed Sensors |
| 4 | Central Information Display | 9 | Dynamic Stability Control |
| 5 | Controller | | |

## FTM System Overview (5 and 6 Series E6X)



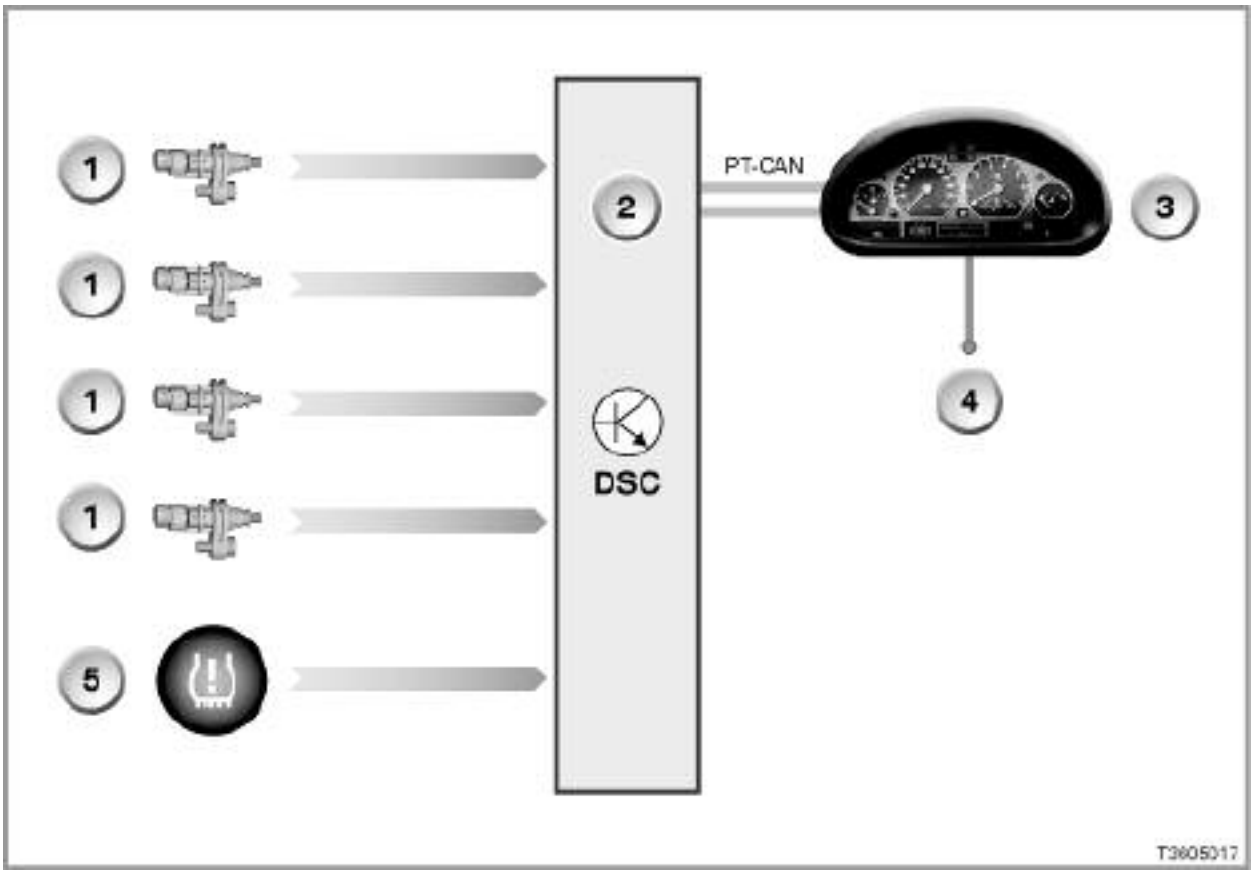

| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | Wheel speed sensors | 6 | Controller |
| 2 | DSC Control module | 7 | Instrument cluster |
| 3 | M-ASK or CCC | 8 | SGM (up to 9/05) or KGM (from 9/05) |
| 4 | Car Access System (CAS) | 9 | Diagnosis line |
| 5 | Central Information Display (CID) | | |

## FTM System Overview (E90/E91)




| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | Wheel Speed Sensors | 7 | Instrument Cluster (Kombi) |
| 2 | DSC Control Module | 8 | Diagnostic Bus |
| 3 | Central Information Display (CID) | 9 | Junction-box electronics (JBE) |
| 4 | M-ASK or CCC | 10 | Steering Column Switch Cluster (SZL) |
| 5 | Controller (CON) | 11 | Turn Signal Stalk Switch |
| 6 | Car Access System (CAS) | | |

# FTM System Overview (E85/E83/E53/E46)




| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | Wheel Speed Sensors | 4 | Diagnostic Bus |
| 2 | DSC Control Module | 5 | RPA/FTM Reset button |
| 3 | Instrument Cluster (Kombi) | | |

## System Components

FTM systems consist of the following major components:

- Wheel Speed Sensors
- FTM Reset Button (used for system reset a.k.a. initialization).
- Warning Indicator Lamp
- Check Control Display (E39 M5)
- Control Display E65/E66 (or CID on 5 and 6 series)
- FTM (RDW) Control Module (used only on early systems such as E39 M5, E46Xi and E52 Z8)

### Wheel Speed Sensors

The wheel speed sensors, which are already part of the ABS/DSC system provide information regarding rotational speed variations between wheels. The wheel speed signals are compared to determine the amount of tire pressure loss.

These sensors vary in design depending upon vehicle. These systems use “active” type sensors which can be hall effect or magneto resistive.

## FTM Reset Button

The reset button (1) is used to initialize (reset) the system. The reset procedure allows the FTM system to “learn” the tire rotational speeds at various vehicle speed ranges.


The button provides a ground input to the DSC module (or RDW module on early systems). It is located near the center console in the SZM (vehicle dependent).

The button can be found on the E46, E53, E83, E85, E52 and E39 (M5).

### E90 Reset

The E90 (without CCC) requires the use of the turn signal stalk to reset the FTM system. The reset is in the instrument cluster.


To reset the FTM system, press button (2) on the turn signal stalk up or down until the appropriate menu is displayed.

When the correct menu is attained, press the “BC” button (2) to confirm selection.

Press the BC button for 5 seconds until the menu displays a “checked box” next to the “INIT” indicator.

## Soft Key Reset

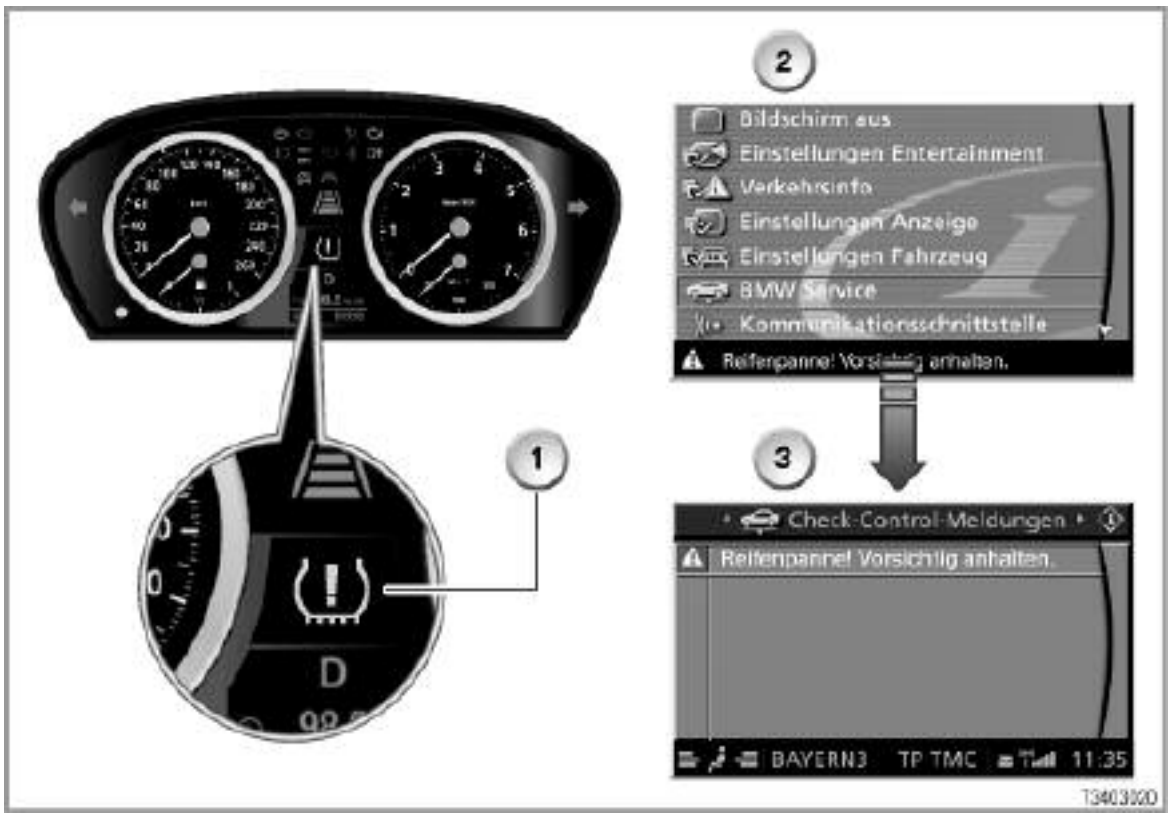
On vehicles which use a Control Display such as E6X or E90/91 with CCC, the FTM system is reset via a “soft key” in the “Vehicle Settings Menu”. The controller is used to reset the system when needed.


## Warning Lamp

Depending upon the vehicle, there will be a yellow FTM indicator lamp in the instrument cluster. The location will vary between models.

## Central Information Display

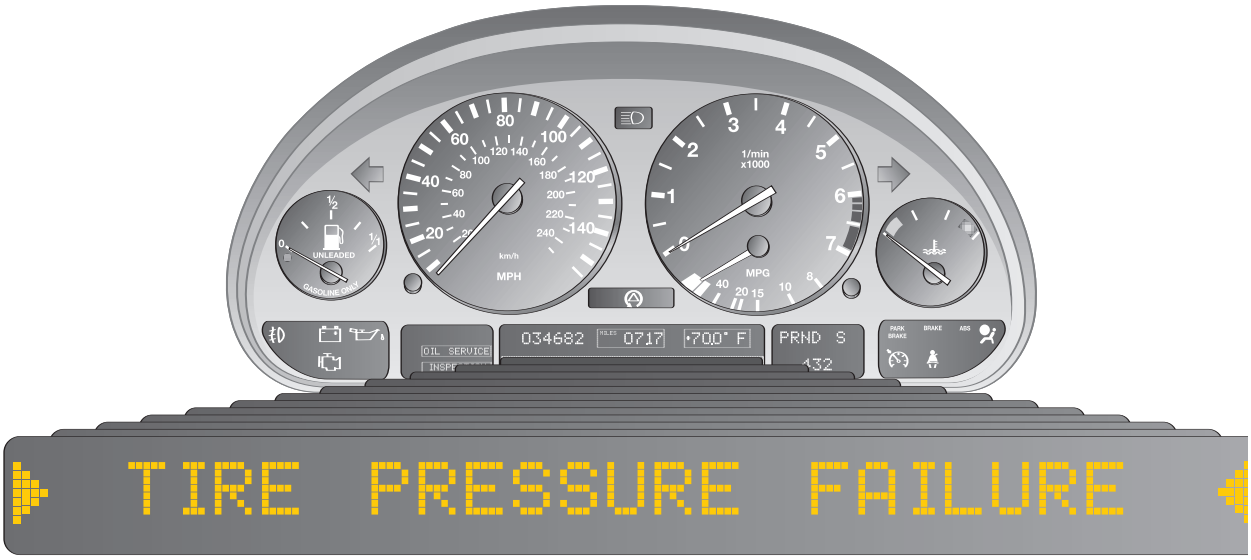
A fault in the FTM or drop in tire pressure will be indicated by the FTM indicator and warning light in instrument cluster.  At the same time, the symbol will light up in the LC display.




| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | Cluster warning light for FTM | 3 | CC Message “Tire Puncture” |
| 2 | “Vehicle Setting Menu” | | |

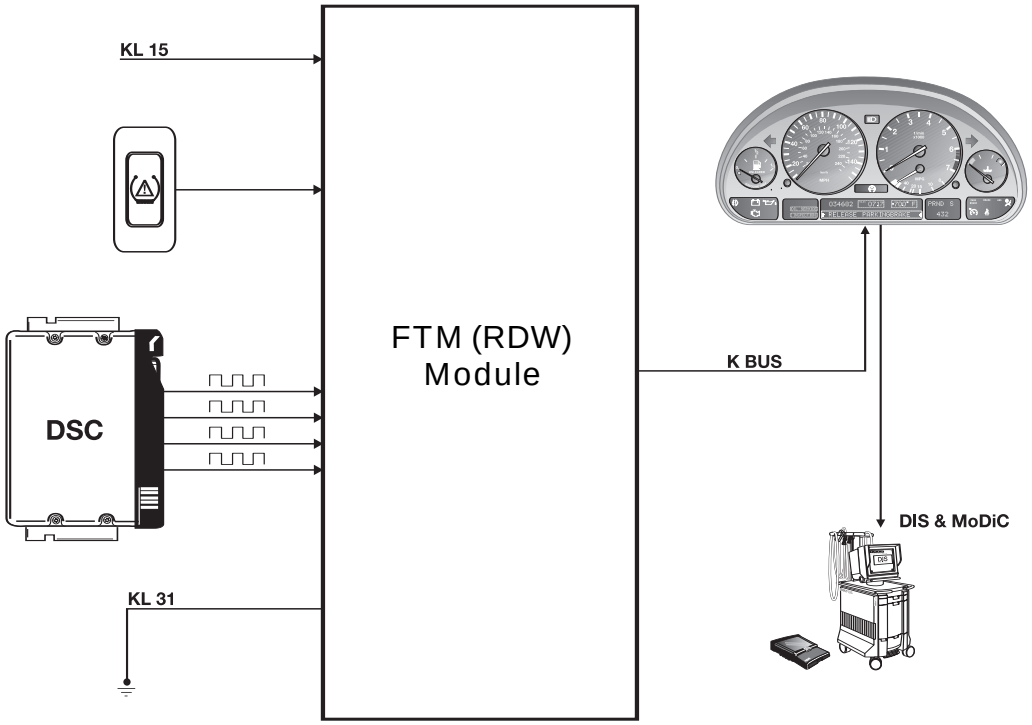
## Check Control Display

The E39 M5 displayed the CC messages in the instrument cluster matrix display. The tire pressure failure message is displayed here in the event of a tire pressure loss or system malfunction.



## FTM Control Module

The FTM systems on the early vehicles such as the E39 M5, E52 Z8 and E46 AWD utilized a separate control module for the FTM system. The control module received wheel speed input from the DSC module. The wheel speed signals were evaluated in the FTM module. If any faults or rotational irregularities were determined, the FTM module would signal the cluster via the K-bus.




## System Software

The newer FTM systems do not utilize a separate FTM module. The operating software in distributed to other modules (usually the DSC module). The system operating software is located in the following modules:

- E65/E66 - The software is located in the CIM. The CIM receives wheel speed input from the DSC.
- E39 M5, E52 Z8 and E46 AWD (xi) - The system software is located in the FTM control module.
- All other vehicles with FTM - The operating software is located in the DSC.

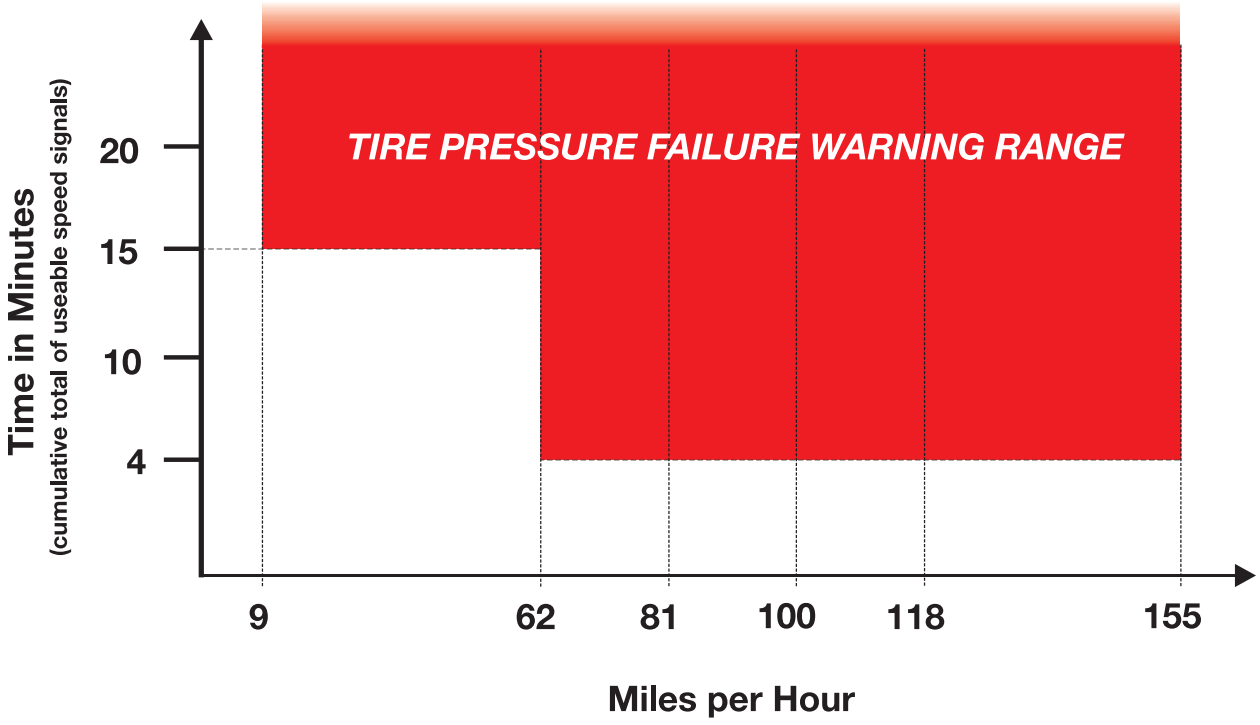
## FTM System Operation

The FTM system is designed to inform the driver of a loss in tire pressure. Rather than monitor actual tire pressure (as direct systems do), the rolling circumference is calculated from the wheel speed signals. When a tire loses pressure, the circumference decreases which corresponds to an increase in wheel speed. The wheel speeds are compared with one another for the purpose of determining rotational irregularities.

A difference in wheel speed is recognized as a pressure loss. The FTM system can inform the driver after a short drive if there is a possible under-inflated tire. Depending upon the vehicle, the driver is warned via an indicator light in the cluster or by a check control message. A gong will sometimes accompany the warning light as an additional method of alerting the driver.

When pressure loss from the tire is gradual, the driver may not perceive a problem until the vehicle handling is compromised. The condition is made difficult to visually detect when “Run Flat” tires are used. This is due to the additional sidewall stiffness which can “mask” an under-inflation situation. The FTM system can alert the driver in advance of any pressure loss in the tires.

The FTM system will detect a drop in pressure below about 30 % ± 10 % of the initial value. The FTM indicator and warning light indicates a drop in tire pressure. The FTM system will indicate this after just a short distance. Usually, after a few minutes, from a certain minimum speed (e.g. 25 km/h) up to the permissible top speed.



During the reset process, the set tire pressure is taken as the initial value for the current set of tires. If all 4 tires lose pressure at the same rate, the wheel speeds will also change at the same rate. The RPA is unable to detect a uniform drop in pressure in all tires (e.g. due to diffusion = natural loss of air from all 4 tires)

As per BMW guidelines, the tire pressure should be checked regularly. The owner's manual states at least twice a month and prior to any long trips. Tire pressure information can be found on the tire pressure placard on the b-pillar. There are also tire pressure charts in the owner's manual as well.

Note: The overall responsibility for the maintenance of correct tire pressure resides with the driver at all times.

### Spare Tire

When using the "space saver" type spare tire, be aware that the FTM system will not operate properly due to the reduced overall diameter of the spare tire. Have the tire repaired as soon as possible to ensure a high level of driving safety.

## System Functions

The Run Flat Indicator (RPA) comprises the following functions:

- Self-test
- Reset (Initialization)
- Detects drop in tire pressure
- Visual and acoustic warning

### Self Test

The RPA performs a self-test when terminal 15 is switched ON. A fault in the RPA is indicated by the RPA indicator and warning light and by a symbol in the LC display.

### System Reset

Reset is started manually (e.g. by pressing the RPA button). Then (after the journey has started), Initialization will run as a fully automatic calibration sequence. In other words, the circumference of individual tires are recorded and evaluated.

To allow a drop in tire pressure to be detected, the system considers different speed ranges and driving situations. Taking account of the driving situation means that the system has to be primed for each speed range individually.

From 09/2004, these speed ranges and driving situations have been combined into 3 calibration ranges. This means greater clarity for output via the BMW diagnostic equipment.

The reset (initialization) phase lasts approximately 5 to 15 minutes for the individual speed ranges. The end of the reset phase is not indicated.

### Detects Drop in Tire Pressure

The RPA records the wheel speeds using the wheel-speed sensors from the DSC. The RPA compares the speeds of the individual wheels and computes an average speed. In this way the RPA is able to detect a loss of tire pressure. (In the event of a tire losing pressure, the tire rolling circumference of the affected tire is also reduced.)

### Visual and Acoustic Warning

A drop in pressure in one tire of approximately. 30 % ± 10 % from the initial value is indicated by the RPA indicator and warning light. In addition, an acoustic signal sounds.

### Signal Output

Depending on the model concerned, either via the instrument cluster, M-ASK or CCC.

Note: In the event of a DSC malfunction, the FTM system will also register a malfunction. This is due to the fact that the wheel speed sensors are monitored by both the DSC and FTM systems.

## Special Conditions for System Function

The following operating conditions may cause a delay in the warning being given in the event of a drop in tire pressure:

- Heavy braking
- Rapid acceleration
- High rate of lateral acceleration
- Cornering (in a tight corner)
- Vehicle speed dropping below a minimum speed (the RPA only responds when a certain minimum speed has been reached)
- Large difference in slip (between axles or between wheel on one side of vehicle)
- Initialization not being completed in current speed range (see "Controls")
- Winter conditions

The following operating conditions may cause a delay in the warning being given in the event of a drop in tire pressure:

- Driving with snow chains fitted

Driving with snow chains may impair the correct function of the RPA. The system will work as normal again after the snow chains have been removed and the vehicle is driven for a few minutes. (The reset process will not need to be repeated)

Note: Do not perform reset (initialization) when snow chains are fitted. The reset process will be affected by the irregularities caused by the snow chains.

## Old or Worn Tires

Only install tires with the same tread depth. Avoid fitting tires with greatly different tread depth (from approximately. 2 millimeters) on one axle. The different diameters mean that the correct operation of the FTM system is no longer guaranteed.

In the following cases, the system will not emit a warning despite a drop in tire pressure being detected:

- The same amount of pressure is lost in 2 or more tires.
- Drops in tire pressures caused by diffusion and affecting all 4 tires equally
- If a tire is damaged with a sudden loss of all pressure (tire blowout, warning is given too late)

## System Reset

The FTM system is reset using the following control elements depending upon vehicle and optional equipment:

- FTM button (all early vehicles w/o CCC or E9X)
- On-board computer button on turn-signal/main-beam switch (E90/91/E92 w/o CCC)
- With iDrive in the Central Information Display (CID) with the controller (all with CCC/NAV)

Note: It is important to always perform a system reset immediately after correcting the tire pressure, especially if a tire is changed or the wheels are interchanged. Only check tire pressures when the tires are cold.

Set the tires to the correct pressure before performing Initialization. During Initialization, the set tire pressure is taken as the initial value for the current set of wheels.

Correct the tire pressures when the tires are cold to prevent the data recorded from being affected by temperature.

Note: The maintenance of tire pressure is the responsibility of the driver.

Check tire pressures regularly, at least twice a month and before embarking on lengthy journeys. During reset, the set tire pressure is taken as the initial value for the current set of tires.

The FTM should be reset during the following scenarios:

- If tire pressure is changed (tire pressure is corrected or reset)
- If the position of the tires is changed (change of axles, wheels), even if the tire pressure is not changed
- If a tire is changed or the wheels are interchanged (e.g. old tires for new tires, summer tires for winter tires, etc.)

## Reset Procedure

The reset procedure is performed with KL15 ON. The engine can be OFF or ON, but do not drive off. Depending on the vehicle, the FTM is reset as follows:

### Vehicles with RPA Button

Press and hold the RPA button until the RPA indicator and warning light lights up yellow for a few seconds. Then drive the vehicle through various speed ranges for at least 15 minutes.

### Vehicles with BC Button (on-board computer function)

In the on-board computer function select "RPA" and "INIT" (LC display) with the rocker switch on the turn-signal/main-beam switch. Press the BC button to confirm.

Press and hold the BC button for approximately. 5 seconds, until a box with a tick appears behind the "INIT" display. Then drive the vehicle through various speed ranges for at least 15 minutes.

### Vehicles with Central Information Display

Initialization is performed via the Central Information Display (CID) and controller.

- Select "RPA/FTM" in the "Settings" menu and confirm.
- Select "Set" and confirm.
- Then drive the vehicle through various speed ranges for at least 15 minutes. The end of the Initialization phase is not indicated.

## Preconditions for Activation

The flat tire indicator is automatically activated when terminal 15 is switched ON. The FTM cannot be switched off manually.

## Flat Tire Indication

A flat tire is indicated as follows:

- E53, E83, E85 - Yellow FTM indicator and warning light without acoustic signal
- E60, E61, E63, E64, E65, E66, E90, E91 - Yellow FTM indicator and warning light with acoustic signal

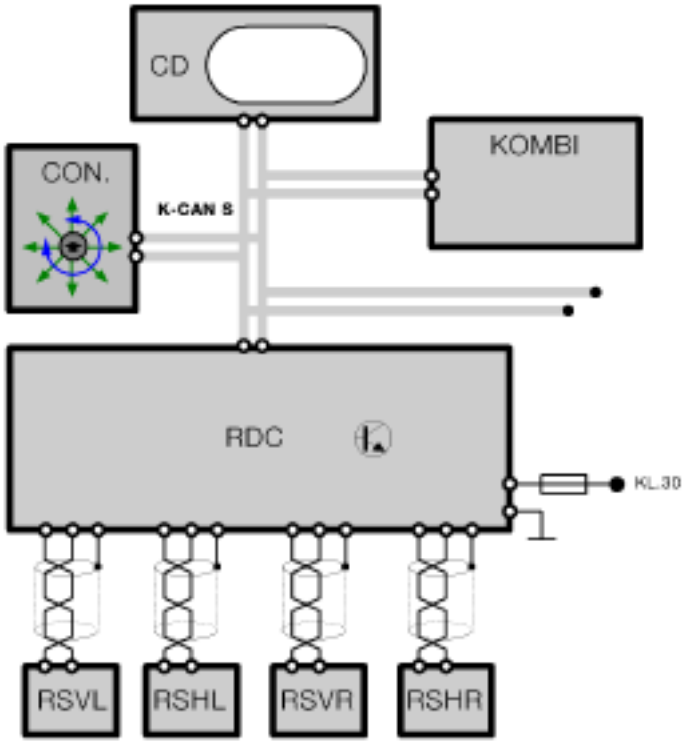
An FTM system failure is indicated by a yellow FTM indicator and warning light without an acoustic signal.

# TPM Systems (up to 2003 production)

TPM systems are “direct”systems which monitor actual tire pressure. The first BMW to use the “direct” system was the early production E65/E66. The system was then referred to as Tire Pressure Control or RDC. The E46 also received an optional version of the RDC type system which was available up to 8/03 production.

The system is capable of monitoring actual tire pressure when the vehicle is stationary or when being driven. There are transmitters which are part of the valve stem assembly. These transmitters send signals to the RDC control unit via antennae mounted in the wheel well area.

When the system detects pressure loss, the driver is warned via a Check Control message and an acoustic warning (gong).




Note: The TPM system on these pages were installed on the E65/E66 and E46 vehicles as options until 2003 production. The newer (NHTSA mandated) TPM systems from 3/2006 are covered on pages 32 through 47.

## TPM System Components

Components of the TPM system differ from the FTM systems. These components include:

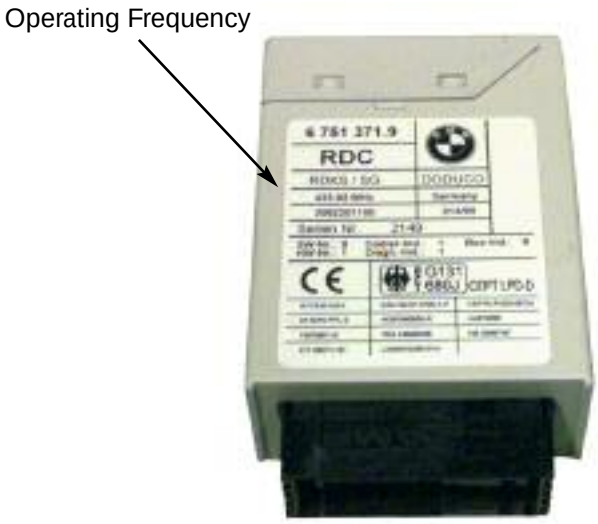
- RDC Control Unit
- Receiving Antennae
- Wheel Transmitter Module
- Warning Indicator Lamp
- Control Display (E6X vehicles)

### RDC Control Unit

The RDC control unit is located behind the glove box on both the E65/E66 and the E46. The control unit is connected to the K-CAN bus on the E65/E66 and the K-Bus on the E46.

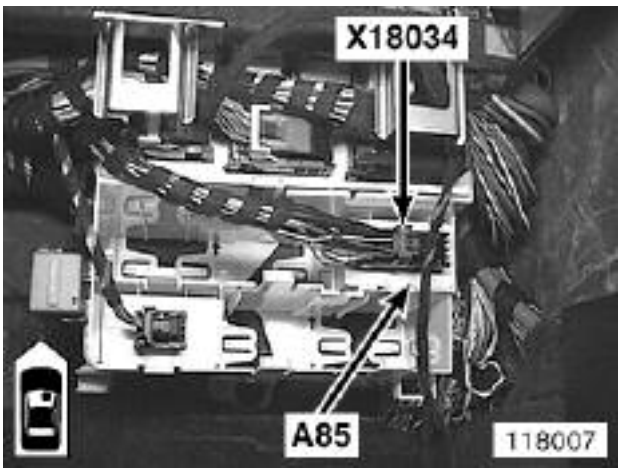
The RDC control unit receives input signals from the 4 antennae and monitors the signals for individual pressure and temperature information.

If the inflation pressure of one of the tires (including the spare) falls below the predetermined threshold, the RDC generates a CC warning telegram on the K-CAN (or K-bus on E46).




The RDC module is designed to operate on a specific operating frequency. It must be matched to the the frequency of the 4 antennae. The systems will operate on two possible frequencies - 315 MHz and 433 Mhz.

The label on the RDC module contains information about the operating frequency. All components including the RDC module, antennae (4) and the 4 wheel transmitter modules must have the same frequency rating in order for the system to operate properly.



RDC Module Location on E46

## Receiving Antennae

The system uses 4 antennae located in each of the 4 wheel well areas behind the splash trim. The purpose of the four antennae is to receive the signals from the wheel mounted transmitters and transfer this information to the RDC control unit.

There are two possible types of antennae used. The 433 Mhz antenna which is black (dark gray) in color and the 315 Mhz antenna which is light gray in color.

Antenna location in wheel well

433 Mhz Antenna

315 Mhz Antenna

## Wheel Transmitter Modules

The wheel transmitter modules are located inside the tire and attached to the valve stem. The modules contain sensors which monitor pressure as well as temperature. There is also a 3.6 volt, long-life lithium battery which is used to power up the sensor electronics as the internal transmitter circuitry.

The transmitter modules are active in an energy saving mode even when they are sitting as spare parts on the shelf.

Each transmitter module has it's own unique ID code. The ID code is assigned to a position on the vehicle (LR,RR etc.) after a successful initialization has been completed.

The radio signal transmitted by the wheel modules is received when the tire passes close to the antenna. The transmitter module measures internal tire air pressure every minute. If the air pressure increases by 0.5 bar between measurements, the transmission rate increases to every 0.8 seconds.

If the increase in air pressure is detected for approximately 216 seconds, the complete functionality of the transmitter is activated. If the higher pressure continues, the module remains permanently active and measures the air pressure and temperature every 0.3 seconds and transmits the information by radio signal every 55 seconds.

At temperatures over 120 degrees Celsius, the transmitter modules are switched off. Once the transmitter module cools below 100 degrees Celsius, operation resumes.

The wheel electronics modules must match the frequency of the antenna and RDC module. If any of these system components are mis-matched, the system will not function correctly.

Note: The valve stem of the spare tire should be pointed to the right rear wheel well. The spare tire is monitored by the RDC module, but not displayed on the screen of the control display. Also, special care should be taking when mounting and dismounting tires from the rims. Damage to the wheel electronics could occur.

## TPM System Operation

During monitoring, the RDC control module takes the measured temperature and pressure readings to determine a target pressure value.

If the tire being monitored falls below the required level by 0.2 bar for more than 8 minutes, a Check Control Message appears in the instrument cluster after the car is started. The driver is prompted to check tire pressure.

### Autumn Warning

If the tire temperature is 20 degrees Celsius lower for 14 days than the previously measured temperature during the last initialization, the RDC system will also prompt the driver to check tire pressures.

| Check Control Message displayed in the Cluster | Message displayed in Control Display |
|---|---|
| Check tire pressures!  | "Check tire pressure!" Check tire inflation pressure; refer to owner's manual or inflation chart. |

When the RDC menu on the control display is activated, the car is shown with the tires highlighted in yellow. The tire pressures must be adjusted and an initialization carried out.

### Tire Failure Warning

After the temperature calculation, if the monitored tire falls below the specified pressure of 0.4 bar, a CC message will appear on the instrument cluster with an audible warning tone. These warnings will also be set if the monitored tire pressure falls by more than 16%. A corresponding CC message will also be shown on the Control Display.

| Check Control Message displayed in the Cluster | Message displayed in Control Display |
|---|---|
| Flat tire! Stop vehicle carefully.  | Left front tire is flat, refer to owner's manual or contact BMW roadside assistance. |

When the RDC menu on the control display is activated, the car is shown with the defective tire in red. In the case of a spare tire failure, all of the tires are shown in red.

Once the tire pressures are restored to the setpoint in the RDC control unit, the tires will return to green in the control display. The CC message is also withdrawn.

## System Reset

After the tires are replaced, rotated or if their inflation pressures are adjusted, then the wheel transmitter modules must be initialized (reset) using the RDC function in the “Settings” menu of the Control Display.

During initialization the following processes are performed:

- Individual wheel recognition (Identification of wheel transmitter modules).
- Wheel position assignment.
- Plausibility check (setpoint pressures checked).
- Adoption of setpoint pressures as specified pressures.

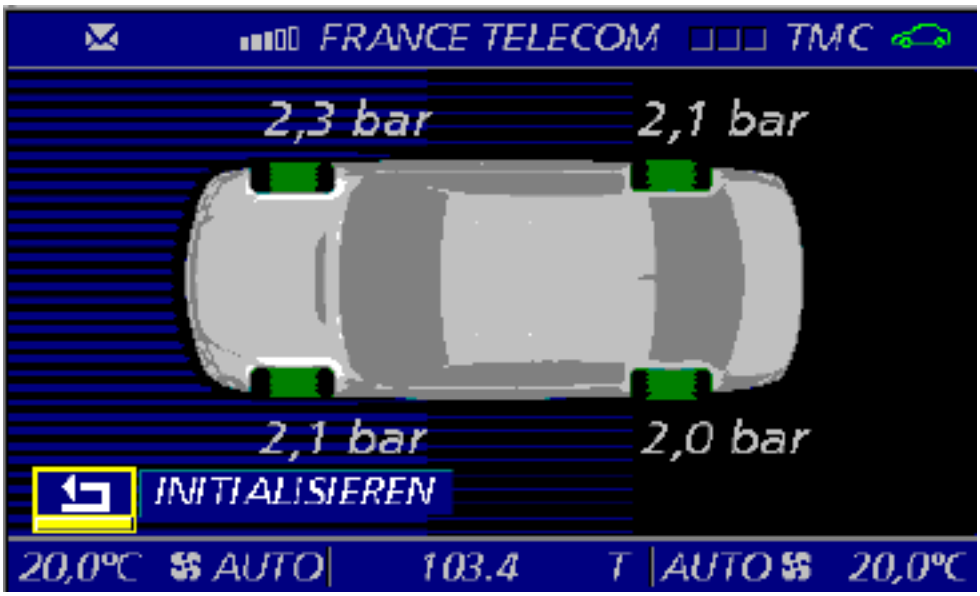
The RDC (TPM) system then learns the wheel transmitter module position.

The minimum air pressure accepted by the TPM system on during reset is 1.7 bar (or 24.7psi). If the tire pressures deviate more than 0.4 bar (6psi) per axle the reset process is rejected after a plausibility check.

1.3 bar is the lowest pressure detected by the wheel transmitter module. At that point, a tire failure warning will always be issued.

Complete reset procedure can take up to 30 minutes. Only the actual driving time over 6 km/h is taken into account. During initialization, the CC message “Initializing RDC!” is displayed on the Instrument Cluster.

When the initialization from the Control Display is activated, the wheels appear black and the pressures are not shown. Once initialization is complete, the tires of the car on the graphic turn green and pressure values are shown for each tire.



# TPM Systems (from 9/05)

As per the TREAD act guidelines, future tire pressure monitoring systems on BMW vehicles will be of the “direct” type. However, there will be some design changes from the first generation “direct” systems. This new system can also be referred to as the “trigger” type system. This is due to the use of trigger transmitter modules which will be explained in more detail later in this section.

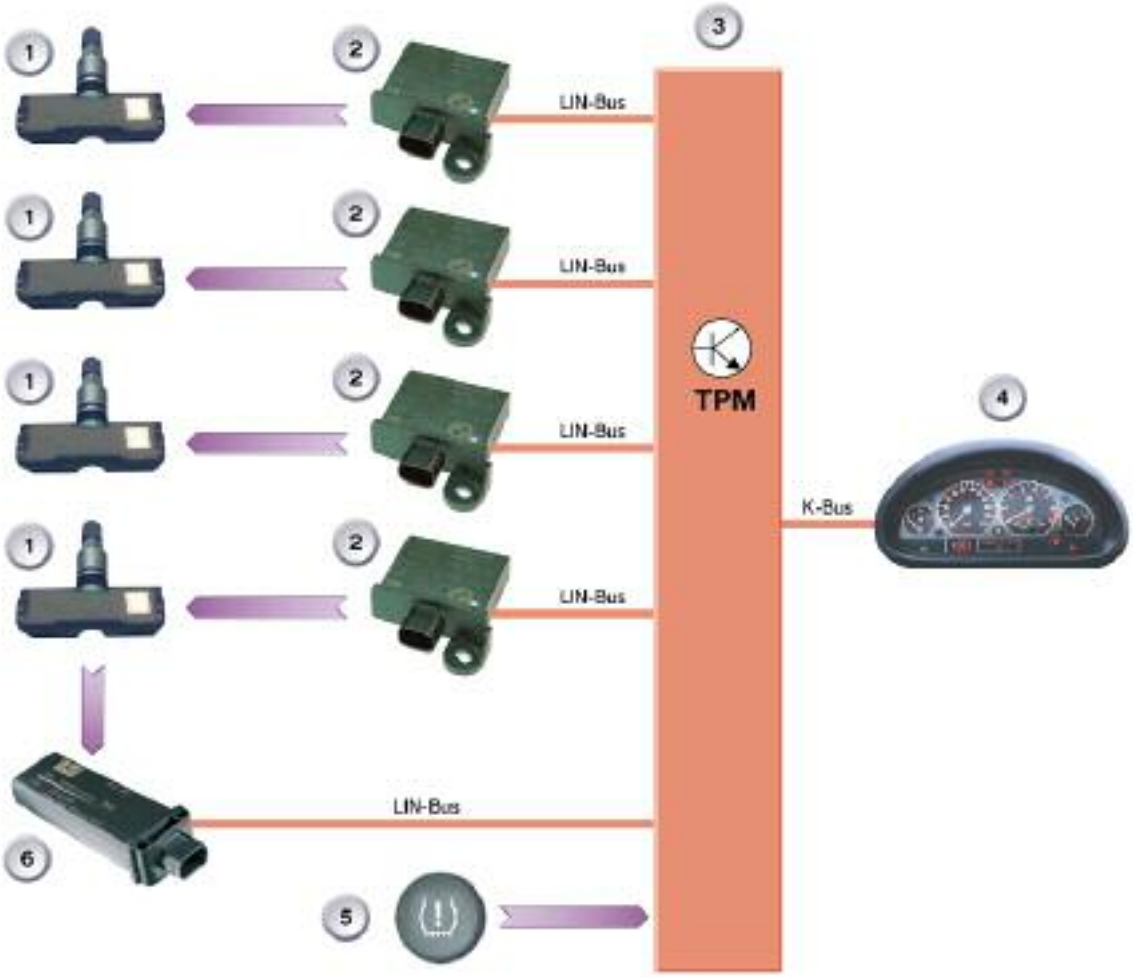
The first models to receive the new systems will be the 5, 6 and 7 series from March of 2006. The X3 will also have the new TPM system from March. The 3 series (E90,91,92) as well as the M5 and M6 will be equipped with the direct system as well. The Z4 will balance out the module line in October. To be in compliance with the new NHTSA regulations, all new models produced from September of 2007 will use the new system.

The main function of the system is to monitor the tire pressure during vehicle operation. The most important auxiliary function of the system is the option of independently detecting the wheels (vehicle's wheels) mounted on the vehicle and their position.

The control unit obtains the radio telegrams from the electronic wheel electronic modules which are controlled via the trigger transmitters. The system recognizes the vehicle's own wheels and the mounting position of the wheels by evaluating the trigger location as well as statistical evaluation of the received information. The control unit checks the individual system components.

The spare wheel is not monitored as the electronic wheel module does not transmit telegrams when stationary (except for the specified post-run phase).

## TPM System Overview

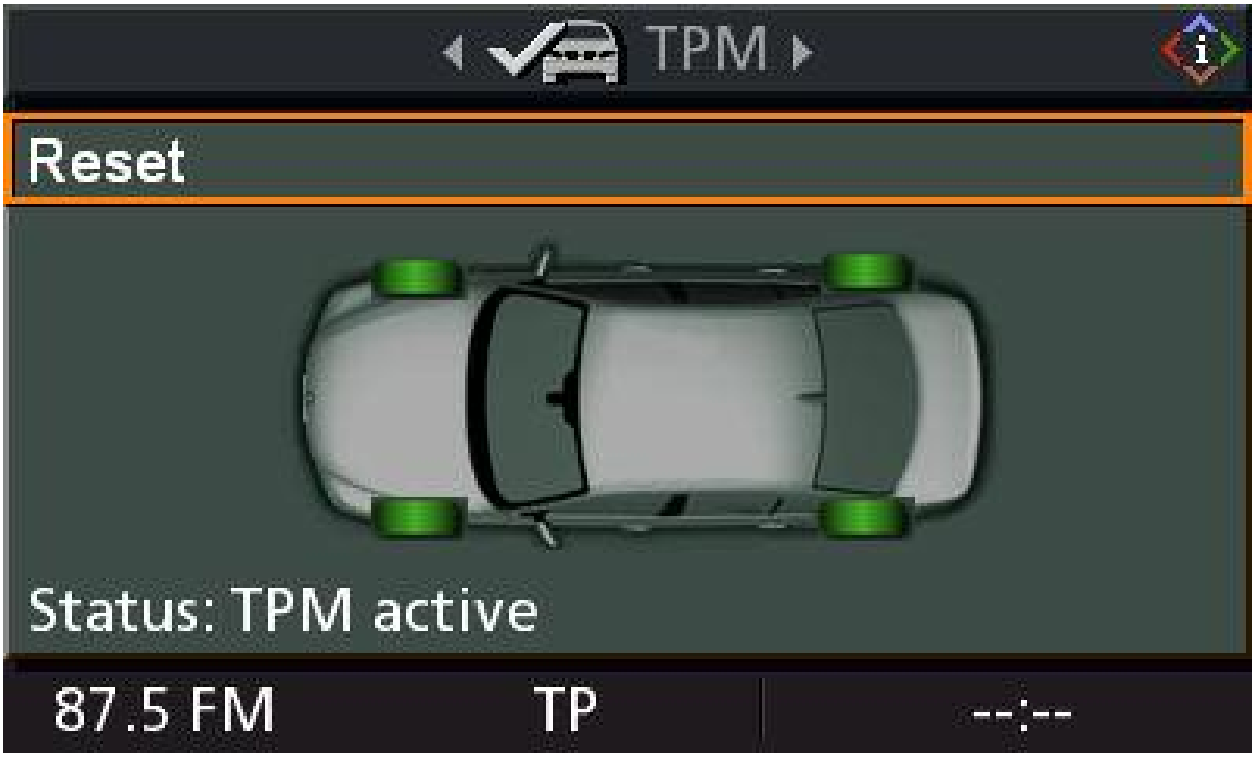



| Index | Explanation |
|---|---|
| 1 | Wheel Electronics |
| 2 | Trigger Transmitter |
| 3 | TPM Control Module |
| 4 | Instrument Cluster Display |
| 5 | Reset (initialization) Button<br>(or via controller with CCC) |
| 6 | Central Receiving Antenna |

## TPM System Components

Components of the new TPM system differ somewhat from the early TPM system. The TPM components include:

- TPM (RDC) Control Unit
- Central (Digital) Receiving Antenna (1)
- Trigger Transmitter Modules (4)
- Wheel Electronics Modules (4 +1 for spare - optional)
- Control Display (E6X vehicles)
- Instrument Cluster



## TPM (RDC) Control Unit

The TPM control unit processes the information received from the central receiving antenna and compares to the previously learned tire pressure data. When the tire pressure deviates from the specified values, the TPM control unit sends a fault telegram which is indicated in the cluster with a corresponding message in check control.

The location of the control unit varies depending upon the vehicle application. Refer to the most current ETM for exact location.


Note: The new RDC (TPM) module is not compatible with earlier TPM systems made prior to March 2006.

## Central Receiving Antenna

The central receiving antenna is a digital antenna which operates on the 433 MHz frequency. The antenna is responsible for receiving the tire pressure information from the wheel electronics modules. This information is then sent to the TPM control module via the LIN interface.

Antenna location is model dependent. The antenna is waterproof which allows external mounting, usually near the center of the vehicle. The LIN bus arrangement ensures that there is no RF wiring inside the vehicle. This eliminates any potential interference from any other systems such as CAS/EWS communication.

The antenna contains a receiving antenna, RF receiver, a LIN bus interface and a microprocessor for demodulating and decoding.

## Trigger Transmitter Modules

The trigger transmitter modules are located behind the inner wheel well trim. There is one transmitter at each wheel. The trigger is responsible for sending command signals to the wheel electronics modules.

The trigger transmitter communicates with the wheel electronics in the 125 KHz range. In order to communicate with the TPM (RDC) module, the trigger transmitters are connected to the LIN bus.

The trigger transmitter is supplied with B+ and ground. The third connection is for the LIN bus.

## Wheel Transmitter Module

The wheel transmitter modules are mounted in the tire and wheel assemblies. The module is fitted to the tire valve assembly as on past models. The module is capable of measuring the tire pressure and the temperature. Acceleration is also measured as a means of determining wheel movement for various operating modes.

The wheel transmitter module transmits information to the central antenna in the 433 MHz range. However, the module receives information and commands from the trigger modules in the 125 KHz range. Therefore, the wheel transmitter module contains the necessary electronics for these two frequency ranges.

Electronic assignment of the wheel electronic modules is not carried out until movement is detected. This is to avoid any signals from vehicles in close proximity. Especially vehicles which are equipped with similar TPM systems.

Data is transmitted to the central receiving antenna via a transmit stage in the wheel transmitter module. The module at each wheel has an individual identifier (ID) which is also transmitted every time data is transmitted. The RF transmission takes place in the 433 MHz range.

Each electronic wheel module transmits at regular intervals (approximately 30 seconds). Also, when there is a trigger request, the measured values are sent. In addition, the tire temperature is measured at regular intervals.

When the tire pressure loss exceeds 0.2 bar, the wheel transmitter module will go into a “rapid-transmit mode” immediately. In this case, the wheel transmitter module measures and sends the information from the tire at shorter intervals.

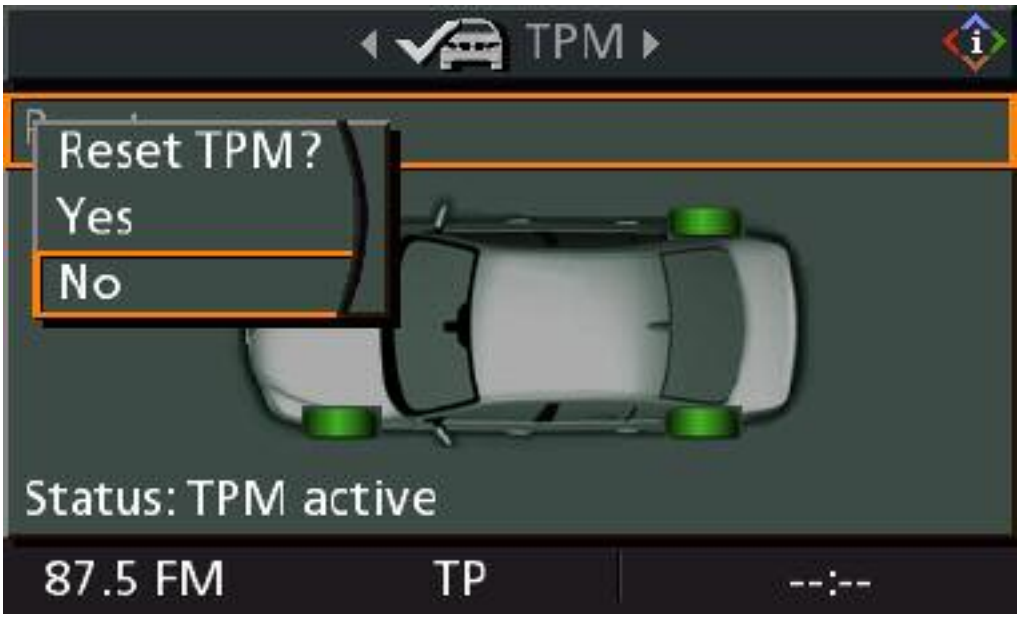
The measured data are sent from the wheel via a transmit stage in the electronic wheel module. A system with relatively few measured data transmission operations is sufficient for tire pressure monitoring if it additionally features an option for detecting fast pressure loss. The electronic module in the wheel can therefore be designed for minimum current consumption and can be battery operated.

## Control Display

On vehicle equipped with a control display, the tire status is indicated in the TPM menu. The tire pressure status is indicated by the color of the tires in the graphic. The colors are as follows:

- Green - Tire pressure is OK and matches the learned tire pressure.
- Yellow - There is a flat tire or a major drop in tire pressure has been detected.
- All wheels yellow - There is a flat tire or major tire pressure loss in several tires.
- Gray - The system cannot detect a flat tire due to a system malfunction or the system is currently in reset mode. Also, any RF interference from other devices can cause this situation.

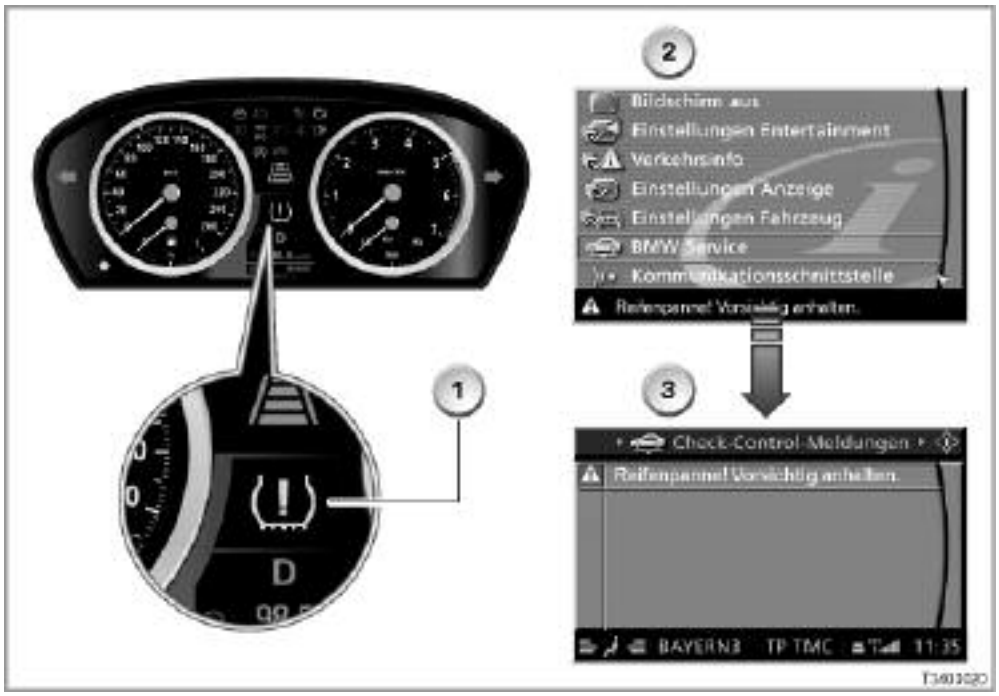
The system reset is also performed using the controller.



## Instrument Cluster

The TPM indicator is located in the instrument cluster. The indicator is yellow and alerts the driver to the CC message in the control display. Also, any system malfunction is indicated by a flashing yellow indicator followed by a continuous illumination.

When this occurs, the tires in the control display will be shown in gray.




| Index | Explanation | Index | Explanation |
|---|---|---|---|
| 1 | TPM warning indicator (yellow) | 3 | CC Message |
| 2 | Vehicle setting menu | | |

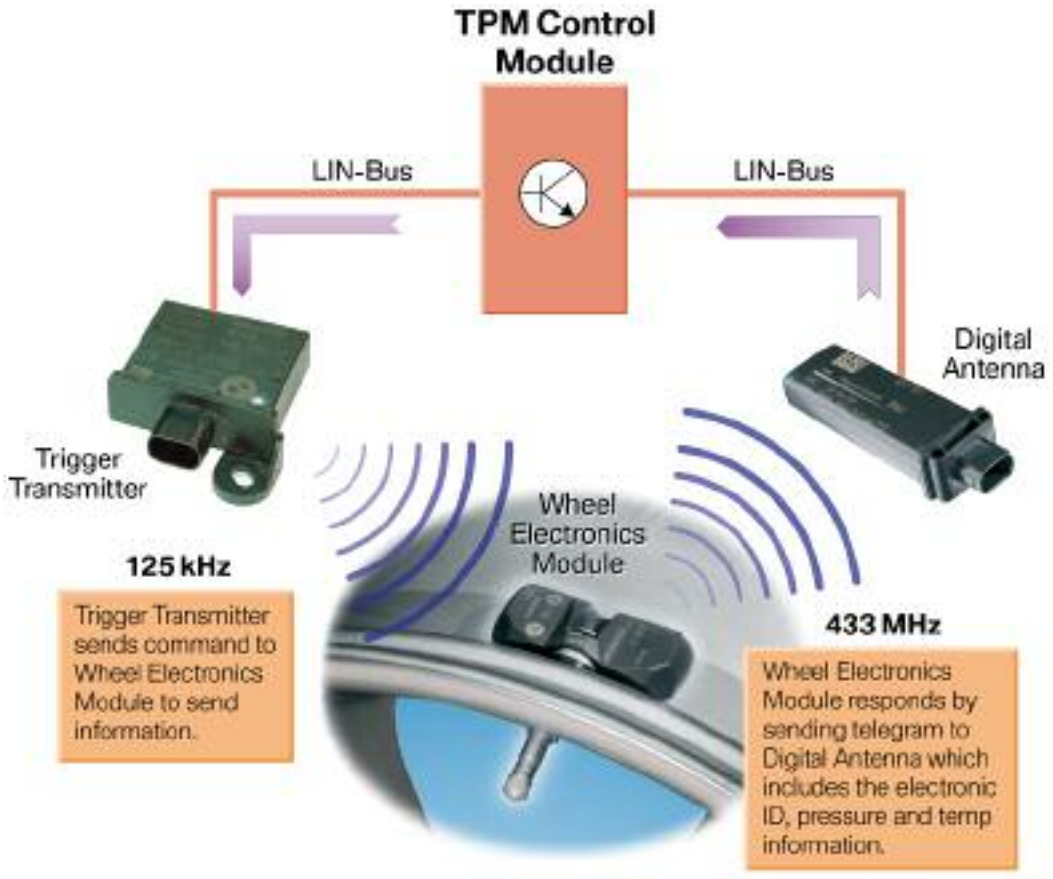
## System Operation

The primary responsibility of the new TPM system is to monitor tire pressure and warn the driver of impending flat tire situations. This new TPM system is referred to as the "trigger type" system due to the trigger transmitters installed at all four wheel well areas.

This system differs from the past "direct" systems in a few areas. There is only one centrally located digital receiving antenna. This antenna receives input from all 4 of the wheel electronics modules (5 if the vehicle has a full size spare) located in each tire and wheel assembly. The central digital receiving antenna is connected to the TPM control unit via the LIN bus.

The wheel electronics modules will transmit information when prompted by signals from the trigger transmitters. The trigger transmitters communicate to the wheel electronics over the 125 KHz frequency.

In contrast to the past wheel electronics module, the new design has the capability of bi-directional communication. In other words, the wheel electronics not only transmit information but receive information and commands from the trigger transmitter modules.




Note: The wheel electronics from the previous system will not work on the new system.

## Wheel Management

One of the important functions of the TPM system is the ability to manage wheel locations and properly report the correct wheel location. When the vehicle is NOT in motion, the system has the capability to determine where the wheel electronics are located on the vehicle. Each one of the wheel electronics module has it's own unique electronic ID number which is sent to the central receiving antenna.

When an electronic wheel module receives at least 2 telegrams in response to a trigger signal, this electronic wheel module is marked as the system wheel.

The wheel position assignment of an wheel electronics module is also based on the response to the trigger signal. Once the assignment has been determined, the positions are stored in an non-volatile memory (NVRAM).

Based on the information of the acceleration sensor in the electronic wheel module, a distinction is made between the spare wheel and the remaining road wheels in the road wheel detection module for the purpose of assisting wheel position assignment.

In order to avoid any signal conflict from adjacent vehicles (with similar TPM systems), the "learning" procedure is performed only while the vehicle is driving.

The wheel management function uses a "confirmation phase" to establish whether the previous wheel assignment order is still correct or whether any new wheels have been installed or rotated for service. The confirmation phase is necessary so that the system can automatically detect changes in the mounted wheel order.

The check takes place during vehicle operation (while driving), in order to rule out any potential signal interference from adjacent vehicles.

## Control Display Screens

### One Tire with Reduced Pressure

The yellow indicator lamp in the instrument cluster is switched on permanently and an audible indication (gong) is additionally sounded as soon as a tire undershoots one of the previously specified warning limits. If the vehicle is equipped with the corresponding option, the test "Low Tire" is additionally shown together with the position in the cluster. If the vehicle is equipped with an control display (MMI), the affected tire is indicated in yellow. The unaffected wheels retain their green color.

The "Low Tire" status means that driving safety is no longer ensured. The driver is requested to stop and check the condition of the tire. It is the responsibility of the driver to decide whether he can continue the journey at low speed to the next repair workshop or whether an on-site repair is necessary.

### Several tires with Reduced Pressure

The yellow indicator lamp in the cluster is immediately switched on permanently and an audible indication (gong) additionally sounds as soon as several tires undershoot the previously specified warning limits. If the vehicle is equipped with the corresponding option the text "Low Tire" is additionally indicated without the position in the instrument cluster. All wheels are now shown in yellow in the MMI.

If a warning is already in effect, on the occurrence of the second warning event, a position-specific warning is replaced by the nonspecific warning. Each tire failure event is signalled audibly.

## Workshop Hints

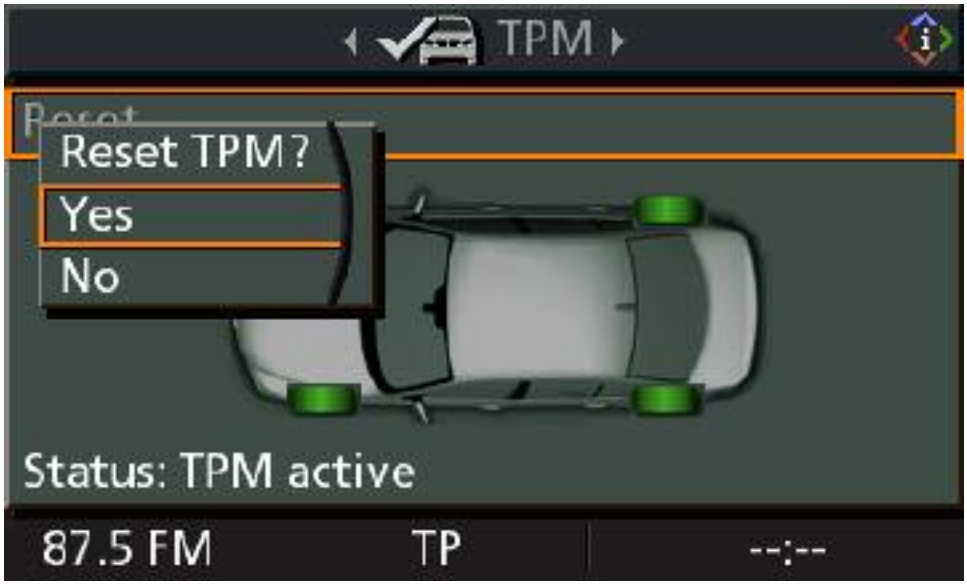
### System Reset (Initialization)

The TPM system should be reset whenever any changes are made to the tire and wheel assemblies. For example, if a tire is replaced or if the tires are rotated for service. Also, the system should be reset whenever any repairs are made to the TPM system.

The driver of the vehicle is solely responsible for maintaining the correct tire pressure when in use. As per BMW recommendations, the tire pressure should be checked 2 times per month.

Before system reset (initialization), the technician (or driver) should set the tire pressure to the specified pressure (as dictated by the tire pressure placard in the b-pillar). These pressures are a cold specification and should be set as such.

Depending on the vehicle, the system reset can be carried out via a button or via the controller (on vehicles with a control display i.e 5, 6 and 7 series).




Once the reset mode is initiated, the vehicle must be driven in order to complete the process. This is to ensure that there is no RF interference or erroneous signals from other vehicles which use similar TPM system components.

During this period, the control display will show the message “Status: Resetting TPM”. The tires on the control display will be gray in color until the process in complete. This should take only a few minutes.

When the reset is complete, the yellow TPM indicator will go out. The tire pressure and temperature values are stored in conjunction with the ID of the wheel electronics. Therefore, the wheel position is stored in the TPM control unit.


In order for the reset procedure to be completed, the tires must be at the minimum allowable pressure which is approximately 1.4 bar (20 psi) to 1.6 bar (23 psi). If the tire pressure is too low, the system will not complete the reset procedure. When complete, the control display will switch to “Status” TPM active” and the tires will switch to green.


Note: New target pressures are adopted solely by way of Initialization. If a wheel is exchanged and the system is not re-initialized, the newly mounted wheels will be “taught-in” and monitored to the previous target pressures.

# Run Flat Tire Technology

Run Flat Tire (RFT) technology has been in development by the tire industry for many years. An RFT tire allows the driver to continue safely in the event of a tire puncture or complete loss or tire pressure. The sidewalls on an RFT tire a specially reinforced to support the vehicle with zero air pressure.

The RFT tire design maximizes safety and allows the driver to maintain vehicle control in the event of sudden or slow air pressure loss. This also eliminates the need for the driver to changes tires in unsafe situations. Therefore, the spare tire and jacking equipment can be deleted from some vehicle.

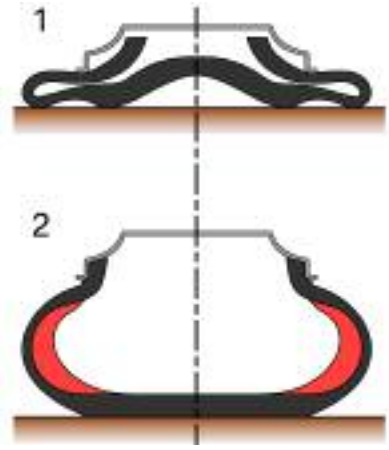
The first U.S. model BMW to be equipped with RFT technology was the E52 (Z8). The Z4, which has standard RFT, takes advantage of the reduced space requirement. Many current model BMW vehicles have standard RFT or they are available as an option.

## RFT Operation

If a slow or sudden pressure loss occurs in a RFT, mobility is maintained due to the additional high temperature rubber reinforcements that strengthen the side wall.

These reinforcements prevent side wall damage when the tire is deflated and also provide support during extreme loads. In addition, the special wheel for the RFT tires "grips" the tire to maintain sufficient steering, braking and accelerating power.

## RFT Design




In the illustration to the right shows a comparison between a standard tire and one equipped with RFT self supporting technology.

Both tires have zero pressure. The non-RFT design (1) shows that the sidewalls will be completely collapsed providing no support.

The RFT design (2), shows that the side walls will maintain limited support for the vehicle to allow the driver to get to a safe area for a tire replacement or repair.

## Tire Manufacturer Information


All "Runflat" tires, regardless of brand must carry a specific designation to indicate that the tire is a "Runflat" system component. Therefore, the tires will have an "RSC" icon on the sidewall.

The chart on the opposing page is a breakdown of the various internal designations from the individual tire manufacturers:

| Tire Manufacturer | Abbreviation/Acronym | Definition |
|---|---|---|
| Bridgestone | RFT | Run Flat Tire |
| Continental | SSR | Self Supporting Runflat |
| Dunlop | DSST | Dunlop Self Supporting Technology |
| Goodyear | EMT | Extended Mobility Technology |
| Michelin | ZP | Zero Pressure |
| Pirelli | PTM | Pirelli Total Mobility |

Note: Due to the characteristics of the self-supporting tire design, a tire which is underinflated may not appear to be low on air pressure. Therefore, always verify actual air pressure with a tire gauge. Do not assume that the tire is properly inflated. Check the tire inflation placard in the driver's side door jamb area for correct inflation pressures.

## Wheel Construction

The wheel design must compatible with the RFT system. A self-supporting tire must be capable of gripping the rim to keep the tire beads intact. The wheels used must be of the "double-hump" design.

The "double-hump" design features 2 raised areas on the rim to help retain the tire bead.

These are referred to as EH2 wheels as opposed to the previous "H2" wheels. Standard H2 wheels will accept RFT designed tires but may not retain the tire properly in the event of a failure. This would render the safety features of the RFT system useless.

Note: When the Runflat tire is at zero pressure. The vehicle can be driven up to 100 miles at a maximum speed of 50 miles per hour. Always refer to the vehicle Owner's Manual for specific guidelines.

"EH2" Wheel

## Classroom Exercise - Review Questions

1. What is the difference between “direct” and “indirect” tire pressure monitoring systems?

2. In accordance with BMW guidelines, how often should the tires’ pressure be checked?

3. Where can the correct tire pressure specifications be found?

4. How should the tire pressure be checked?  Hot or Cold (Why?)

5. On the early TPM (RDC) system, is it important for the RDC control module, wheel electronics and antennae to be the same frequency? (Why?)

## Classroom Exercise - Review Questions

6. What is the difference between the wheel electronics modules from the early TPM system (up to 2003) and the new TPM system (from 3/06)? Are the wheel electronics interchangeable between the two systems? (Why?)

7. What is meant by an “EH2” rim?

8. When is necessary to reset a TPM or FTM system?

9. On the new TPM system (from 3/06), how is the spare tire detected and distinguished from the installed wheels?

10. On the new TPM system (from 3/06), what is indicated in the CID when the wheels are displayed in gray?